ISSN (print) 0093-4666 © 2011. Mycotaxon, Ltd. ISSN (online) 2154-8889

MYCOTAXON

Volume 115, pp. 345–351 *January–March 2011*

DOI: 10.5248/115.345

Lichenological notes 2: *Lichenothelia convexa,* a poorly known rock-inhabiting and lichenicolous fungus

Jana Kocourková[1] & Kerry Knudsen[2]

[1]*Department of Ecology, Faculty of Environmental Sciences, Czech University of Life Sciences, Prague, Kamýcká 129, Praha 6 - Suchdol, CZ–165 21, Czech Republic*
[2]*Herbarium, Department of Botany and Plant Sciences, University of California, Riverside CA, 9252–0124, USA*
Correspondence to: [1] *kocourkovaj@fzp.czu.cz* & [2] *knudsen@ucr.edu*

Abstract — *Lichenothelia convexa,* a saxicolous and lichenicolous microfungus, is reported new for the Czech Republic. The poorly known species is provided with a description and is illustrated.

Key words — *Lichenostigma saxicola, Lichenothelia paradoxa*

Introduction

Rock-inhabiting fungi (known as RIF) are common throughout the world. They are rich in diversity (Ruibal et al. 2009) and often collected by lichenologists who study saxicolous lichenized fungi. *Lichenothelia* D. Hawksw. is a cosmopolitan genus of RIF currently comprising 24 species (Robert et al. 2005). The genus *Lichenothelia* was introduced by Hawksworth (1981) for the *Microthelia aterrima* group of fungi with apothecioid ascomata with bitunicate asci, pseudoparaphyses, 1–3 septate to submuriform brown halonate ascospores, and a black areolate non-lichenized thallus. The generic type is *L. scopularia* (Nyl.) D. Hawksw., a widespread species on acid rock or mica schists in Europe and North America, which has mainly 3-septate to submuriform ascospores and an I– hymenium. Hawksworth included a second species in the genus, *L. metzleri* (J. Lahm) D. Hawksw., which has a similar thallus, but differs in having predominately 1-septate ascospores, an amyloid reaction on the outer layers of the asci (I+ blue), and occurs on calcareous rock and serpentine. It is also known from Europe and North America (Hawksworth 1981).

Aino Henssen published 18 new species in the genus on calcareous or non-calcareous rock (Henssen 1987). Five of the species had apothecioid

ascomata with pseudoparaphyses. Henssen emended the genus to include taxa with ascomata with asci developing in cavities within a centrum of spherical cells, describing 13 more species. Henssen's species varied from dispersed to contiguous areoles, becoming lobulate or effigurate thalli in some species. Some produced superficial hyphae called stolons, which usually produce new ascomata. Many taxa produced globose macroconidia, often on stalks, or meristematic offshoots. The centrums were either amyloid or non-amyloid. Some taxa were described as facultatively lichenicolous or fungicolous. The paper excited curiosity among lichenologists, who occasionally collected the more conspicuous rock-inhabiting fungi. But it proved perplexing. It was without a key and only a short diagnosis was given for each species. Most species were not illustrated and the pictures of the thalli, though good for the time, were over-all dark and too small. A monograph was apparently planned but was never completed. Authentic specimens of the new species were rare in herbaria and most types were unavailable for loan as Henssen continued her studies. Few of the types of Henssen's species are accessible now, although Hessen will eventually deposit them in Helsinki (H). Most lichenologists lost interest and stopped collecting the fungi when they found they could not be identified.

In the 23 years since Henssen's paper, only 4 new species have been described. *Lichenothelia antarctica* Øvstedal (Øvstedal & Lewis Smith 2001) has apothecioid ascomata with pseudoparaphyses and large muriform ascospores. It appears to be endemic to Antarctica. *Lichenothelia renobalesiana* D. Hawksw. & V. Atienza (Atienza & Hawksworth 2008) also has apothecioid ascomata with pseudoparaphyses. It has no thallus and is lichenicolous on *Verrucaria* species on limestone in Europe and North America (Kocourková & Knudsen 2009). *Lichenothelia spiratispora* Etayo is similar to *L. renobalesiana* but has smaller ornamented and halonate 1-septate ascospores and is lichenicolous on *Acarospora sphaerospora* H. Magn. (Etayo 2010). *Lichenothelia uralensis* Zhurb. (Zhurbenko 2008) from the Russian Federation has a cellular centrum and dispersed areoles and is known only from the type.

Recent pioneering studies of rock-inhabiting fungi using molecular analysis are renewing interest among mycologists (Ruibal et al. 2009). Currently several species of *Lichenothelia* are being cultured and sequenced. The reconstruction of their phylogeny is anticipated.

We became interested in saxicolous microfungi while studying lichenicolous fungi. We recently described *Lichenostigma saxicola* K. Knudsen & Kocourk. from southern California (Knudsen & Kocourková 2010), a taxon Henssen would have described in *Lichenothelia.* The new species has a non-amyloid centrum of spherical cells, 1-septate ascospores, dispersed thallus, produces stolons, and is both saxicolous and lichenicolous. From the Czech Republic

we examined two taxa with amyloid centrums with spherical cells, both facultatively lichenicolous. The more common species was eventually identified as *Lichenothelia convexa*. In this paper we publish a revised description of *L. convexa* and report it new for the Czech Republic. The other taxon may be new to science or else represent wider variation in *L. convexa* but needs further study and more specimens.

Materials & methods

Specimens of *Lichenothelia calcarea* Henssen, *L. convexa, L. metzleri*, *L. paradoxa* Henssen, *L. renobalesiana, L. scopularia, L. tenuissima* Henssen, as well as *Lichenostigma saxicola* and several probably undescribed taxa from Australia, Europe, North and South America were studied from B, FH, IMS, MIC, SBBG, PRM, UCR, UPS, and the Hb. Mycologicum J. Kocourková & K. Knudsen. Specimens have been examined using standard microscopical techniques with an Olympus SZX 7 Stereomicroscope or an Olympus BX 51 fitted with Nomarski differential interference contrast. Hand-made sections were studied in water and 10% KOH [K]. Amyloid reactions were tested in Lugol's iodine 1% [I] with and without pretreatment with K. Ascospore measurements were made in water with an accuracy of 0.5 µm and given in the form "(minimum–) mean minus standard deviation–mean–mean plus standard deviation (–maximum)" and followed by the number of measurements (n); the length/breadth ratio of ascospore is indicated as l/b and given in the same way. Over-mature ascospores were few and excluded.

Macro- and microphotographs were taken with a digital Olympus D72 camera mounted on an Olympus SZX 7 Stereomicroscope and or an Olympus BX 51 fitted with Nomarski differential interference contrast.

Taxonomy

Lichenothelia convexa Henssen, Bibl. Lichenol. 25: 259 (1987). PLATE 1

TYPE: **GERMANY.** Hessen. Kr. Marburg, Wollenberg, on quartzite rock, 1980, Henssen 26750a (MB, **holotype**)

Vegetative hyphae, 4–5 µm in diam., brown, with granular surface, thick-walled, cells 7–10 µm long, branching not observed, immersed in substrate, usually one per stroma, often absent or hard to observe, I–. Thallus dispersed areolate, stromata sometimes congregated, infrequently confluent but separated by wide cracks, superficial on rock and lichens, not connected to other ascomata by networks of superficial hyphae. Stromata black, irregularly rounded, convex to somewhat flattened, mostly 100–200 × 90–120(–150) µm, some becoming as wide as 400 µm across, infrequently producing 1 to 3 superficial hyphae, "stolons" sensu Henssen (1987), black in dissecting microscope, black-brown with granular surface in light microscope, up to 1 mm long, but often shorter, one cell wide, cells various size, many 4–6 × 4–6 µm, often forming new stroma at tips of stolon, sometimes 3 stromata appearing linked in row. Stromata in

section pseudoparenchymatous, with round to angular cells mostly 4–5 µm in diam., external cells brown with granular surface, internal cells hyaline to light brown, I–, often sterile. Non-ostiolate, opening in apex by wall decay. Asci immersed in cavities in the stromata, bitunicate, broadly saccate to clavate, 20–30(–35) × 10–20 µm, fragile, mostly 8-spored. Intercellular spaces with an I+ blue, K/I+ blue gel, sometimes weak, reaction not observed when ascomata sterile. Ascospores hyaline to light brown when young, becoming darker brown, ellipsoid to broadly ellipsoid, faintly ornamented, halonate at least when young, cells not equal in size, 1–4 septate, sometimes becoming submuriform, (10.0–)10.5–*10.8*–11.5(–12.0) × (5.0–)6.0–*6.1*–6.5 µm (n = 20); l/b = (1.5–)1.7–*1.8*–1.9(–2.1). A few larger over-mature submuriform ascospores were seen, 14 × 6–6.5 µm, but were excluded. (Henssen 1987 gives ascospore measurements of 11–14 × 5.5–6.5 µm). Macroconidia globose, often absent, 10–15(–20) µm. Meristematic outgrowths also produced from surface of stromata of various sizes and shapes.

Ecology and substrate - On non-calcareous rocks and on saxicolous lichens. It is not host specific. In some specimens no damage to the host was observed. In a specimen from Krkonoše National Park, *Knudsen 12560, Lichenothelia convexa* is clearly pathological on the thallus of a *Lecidea* species.

Distribution. — Europe (Czech Republic, Germany, Sweden, United Kingdom), Asia (Turkey), North America in the United States (California, Colorado, Washington) (Halıcı et al. 2006; Hawksworth 1992; Henssen 1987).

Specimens examined. — **CZECH REPUBLIC.** East Bohemia. Krkonoše National Park, Krkonoše Mts, map of Czech Republic. 50°43'20"N 15°42'03"E, 1426 m, on granite outcrop and *Lecidea* species, 10 Oct. 2010, *K. Knudsen 12560 w/ J. Kocourková* (Hb. Mycologicum Kocourková & Knudsen). Central Bohemia. Distr. Praha, Pitkovice, Pitkovická stráň, 50°1'26"N 14°34'21"E, 276 m, on shale and *Rinodina aspersa*, 21 Sept. 2010, *J. Kocourková 7744* (Hb. Mycologicum Kocourková & Knudsen), on shale and *Acarospora gallica*, *Knudsen 12452* (BM, GZU, Hb. Mycologicum Kocourková & Knudsen); Nová Ves, Prokopské valley, Hemrovy rocks, 50°2'34.88"N 14°21'11.613"E, 265 m, on west-facing slope above road, on diabase and *Acarospora fuscata*, 7 June, 2010, *J. Kocourková 7404* (Hb. Mycologicum Kocourková & Knudsen); **GERMANY.** Hessen. Kreis Marburg/Biedenkopf, TK 25: 5117 Buchenau, Wollenberg, Wichtelhäuser, Hohler Stein, 385 m, on quartzite, 13 Aug. 1989, *H. T. Lumbsch & E. Mietzsch 6948* (B, topotype); Harz. Selketal, Meiseberg, 3 June 1990, *H. T. Lumbsch* (B).

Discussion

Lichenothelia convexa is widespread and probably under-collected. We report it as new for the Czech Republic, where it appears to be infrequent on non-calcareous rock (although often locally common on diabase and shale) and is often sterile. Unlike *L. scopularia*, *L. metzleri,* or *L. paradoxa,* all of which have conspicuous black areolate thalli, the dispersed areolate thallus of

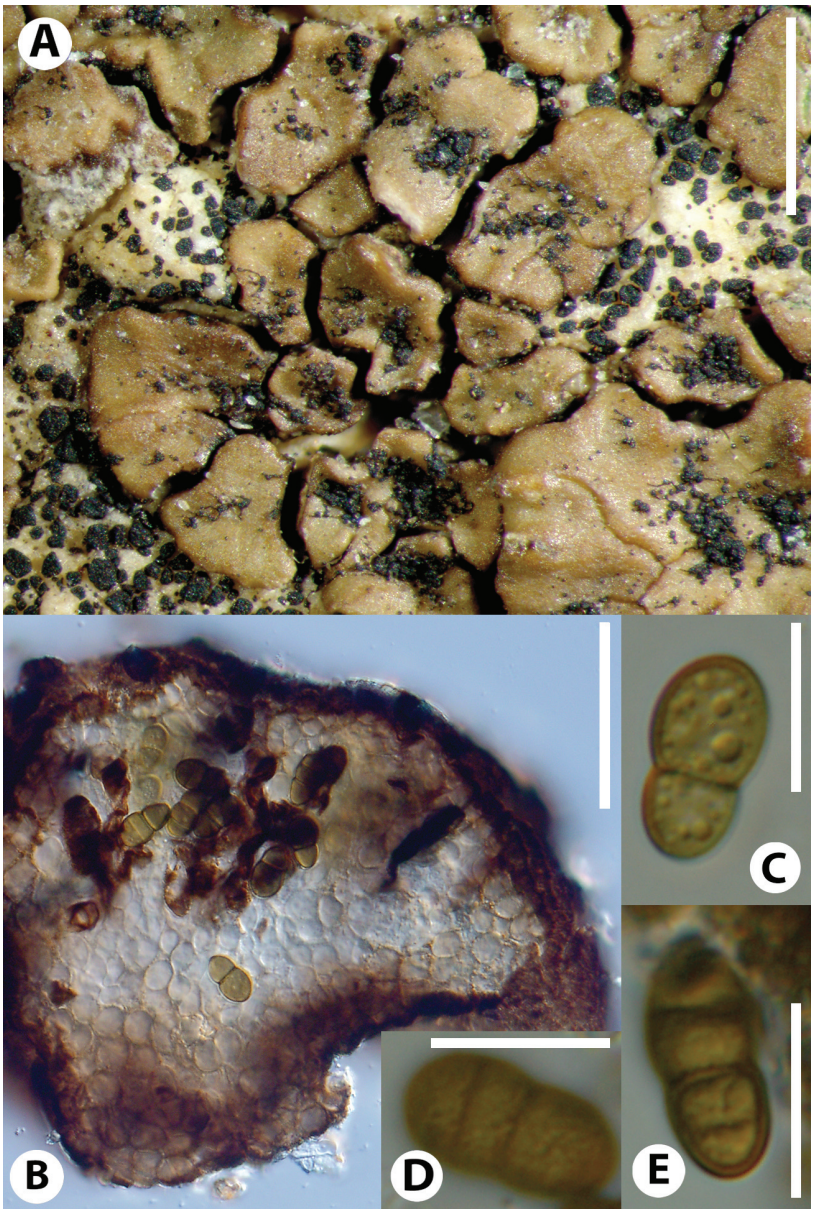

Plate 1. A, *Lichenothelia convexa* on *Acarospora fuscata* and rock (*J. Kocourková 7404*, scale = 1 mm). B, Section of stroma of *L. convexa* (scale = 20 µm). C, Young 1-septate halonate ascospore (scale = 10 µm). D, Faintly ornamented surface of ascospore (scale = 10 µm). E, Spore with 3 septa becoming submuriform (scale = 10 µm).

L. convexa looks like the dispersed thalli of many rock-inhabiting microfungi seen on calcareous and non-calcareous rock throughout the world. Rarely does *L. convexa* form a more confluent thallus of stromata separated by wide, deep cracks.

In southern California, *Lichenothelia convexa* resembles *Lichenostigma saxicola,* which is distinguished by thinner usually hyaline or light brown stolons, 1-septate ascospores, and a non-amyloid centrum and which occurs at relatively low elevations in desert and coastal xeric habitats (Knudsen & Kocourková 2010). *Lichenothelia convexa* was collected in California at a mesic low elevation site (Silverwood, San Diego County) and higher elevation montane sites (Yosemite in the Sierra Nevada Mountains and Mt. Baldy in San Gabriel Mountains) (Henssen 1987). *Lichenostigma saxicola,* which has not been reported yet from Europe, is currently considered endemic to western North America and may be a predominately desert species.

Henssen (1987) originally described *Lichenothelia convexa* as having 3–4 septate ascospores, but our observations show the ascospores to be variably 1–4 septate. We also observed a K/I+ blue stain in the apex of the ocular chamber and lacking an amyloid ring. Further study of fresh material, best for taxonomic study, is needed, as good asci for staining were insufficient in our specimens. Sterile stromata are common.

Lichenothelia paradoxa is currently known only from Slovakia on quartzite but is expected in the Czech Republic. It resembles *L. scopularia,* but *L. paradoxa* has paraplectenchymatous stromata with asci forming in cavities rather than apothecioid ascomata with pseudoparaphyses. Otherwise the brown ascospores with 2 or 3 septa are similar in size to the ascospores of *L. convexa.*

Acknowledgments

We thank our reviewers, James C. Lendemer (NY) and M. Gökhan Halıcı (University of Erciyes, Turkey). We thank the curators of B, FH, IMS, MIC, UPS and SBBG. The work of Jana Kocourková was supported financially by the grant "Environmental aspects of sustainable development of society" 42900/1312/423114 from the Faculty of Environmental Sciences, Czech University of Life Sciences Prague.

Literature cited

Atienza V, Hawksworth DL. 2008. *Lichenothelia renobalesiana* sp. nov. (*Lichenotheliaceae*), for a lichenicolous ascomycete confused with *Polycoccum opulentum* (*Dacampiaceae*). Lichenologist 40(2): 87–96. doi:10.1017/S0024282908007342

Etayo J. 2010. Líquenes y hongos liquenícolas de Aragón. Guineana 16: 1–501.

Halıcı MG, Kocakaya M. & Aksoy A. 2006. Additional and interesting lichenized and lichenicolous fungi from Turkey. Mycotaxon 96: 13–19.

Hawksworth DL. 1981. *Lichenothelia*, a new genus for the *Microthelia aterrima* group. Lichenologist 13: 141–153. doi:10.1017/S0024282981000182

Hawksworth DL. 1992. *Lichenothelia* D. Hawks. (1981). 359–360, in: Purvis OW, Coppins BJ, Hawksworth DL, James PW, Morse DM (eds.): The Lichen Flora of Great Britain and Ireland. British Lichen Society, Natural History Museum Publications, Great Britain.

Henssen A. 1987. *Lichenothelia*, a genus of microfungi on rocks. Bibliotheca Lichenologica 25: 257–293.

Knudsen K, Kocourková J. 2010. A new *Lichenostigma* species (genus incertae sedis) from southern California. The Bryologist 113(2): 229–234. doi:10.1017/S0024282908007342

Kocourková J, Knudsen K. 2009. Three lichenicolous fungi new for North America. Evansia 26(3): 148–151. doi:10.1639/0007-2745-113.2.229

Øvstedal DO, Lewis Smith RI. 2001. Lichens of Antarctica and South Georgia: A guide to their identification and ecology. Studies in Polar Research, Cambridge University Press, Cambridge, England. 411 pp.

Robert V, Stegehuis G, Stalpers J. 2005. The MycoBank engine and related databases. http://www.mycobank.org

Ruibal C, Gueidan C, Selbmann L, Gorbushina AA, Crous PW, Groenewald JZ, Muggia L, Grube M, Isola D, Schoch CL, Staley JT, Lutzoni F, de Hoog GS. 2009. Phylogeny of rock-inhabiting fungi related to *Dothideomycetes*. Studies in Mycology 64: 123–133.

Zhurbenko MP. 2008. A new species from the genus *Lichenothelia* (*Ascomycota*) from the Northern Ural. Mikologia i Fitopatologia 42(3): 240–243.